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(54) Torque wrench with angle sensor without external reference

(57) An electronic torque wrench comprises a head (12) for coupling with a member to be tightened, a first sensor (14) for detecting the torque generated on the head upon moving the wrench, a second sensor made up of a gyroscope (17) for detecting angular rotation of the head, means of calculation to find from the sensor detection information considered significant.

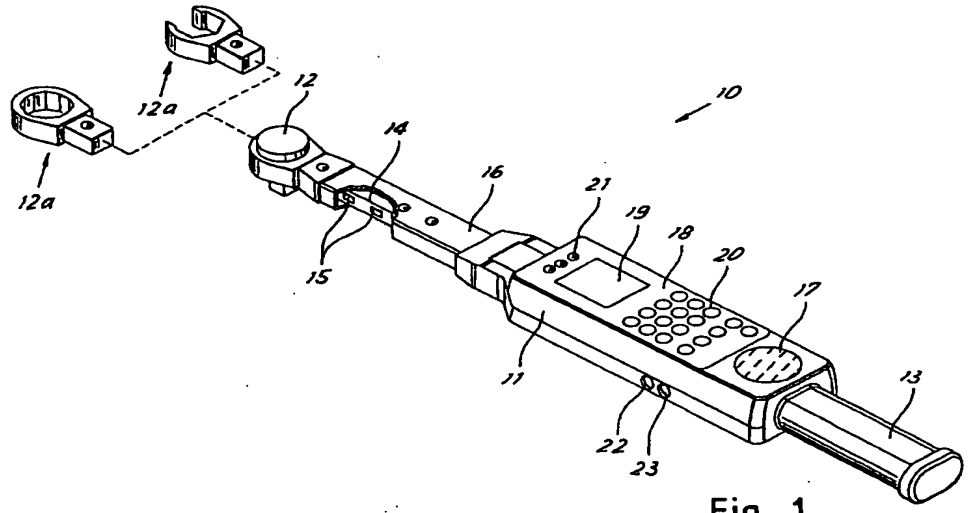

Fig. 1

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Description

[0001] The present invention relates to a torque wrench of the type comprising an angle sensor.

[0002] In the prior art there are known torque wrenches with torque and angle measurement, for example for tightening to the elastic limit, checking bolts already tightened, analysis of tightening to breakage, et cetera.

[0003] For measurement of the angle there is generally employed a potentiometer or an encoder mounted on the axis of the wrench head generally equipped with a ratchet. The angle is calculated with the potentiometer or the encoder by measuring rotation of the wrench head with respect to a an external reference point obtained by connecting the measurer shaft to an external reference by means of a flexible rod terminating with a magnet or an anchoring clamp.

[0004] The need for an external reference makes use of the wrench scarcely practical as it is necessary to connect the angle measurement system to an external reference not always available. In addition, for the operator, especially under not optimal work conditions, for example in uncomfortable positions or limited spaces, it is not particularly easy to connect this reference when his hands are occupied in holding the wrench. In addition, the connection obstructs movement and handling of the wrench. Furthermore, for design reasons, continuous full rotation of the wrench is limited to an angle of 180-240 degrees, forcing a repeated pull when tightening calls for a larger angle.

[0005] The wrench head can be equipped only with a ratchet or a fixed panel, given the presence of the angle measurement member, coaxial with the handling panel, and it is not possible to use for example fork or polygonal wrenches or, even less, special attachments.

[0006] Lastly, play in the angle reference couplings introduces errors and inaccuracy in angle measurement.

[0007] The general purpose of the present invention is to remedy the above mentioned shortcomings by making available a torque wrench permitting rotation angle measurement with no need for fixed references.

[0008] In view of this purpose it was sought to provide in accordance with the present invention an electronic torque wrench comprising a head for connection to a member to be tightened, a first sensor for detecting the torque generated on the head upon moving the wrench, a second sensor for detecting angular rotation of the head, means of calculation to find from the sensor detection information considered significant and characterized in that the angular rotation sensor comprises a gyroscopic sensor.

[0009] To clarify the explanation of the innovative principles of the present invention and its advantages compared with the prior art there is described below with the aid of the annexed drawings a possible embodiment thereof by way of non-limiting example applying said principles. In the drawings:

FIG 1 shows a diagrammatic perspective view of a torque wrench accomplished in accordance with the present invention, and

FIG 2 shows a block diagram of the wrench circuit.

[0010] With reference to the FIGS FIG 1 shows a torque wrench indicated as a whole by reference number 10. The wrench comprises a body 11 at one end of which there is a head 12 for connection to a member to be tightened (not shown) and, at the opposite end, a handling grip 13.

[0011] The head can be of any known type (fork, square, polygonal, et cetera) with or without ratchet and any size. As clarified below, thanks to the innovative principles of the present invention the head is merely a mechanical member of the wrench. It can thus be changeable with a coupling and selected from a plurality 12a of different heads depending on requirements.

[0012] In the connection between the grip and the head there is a torque sensor 14. This sensor is advantageously accomplished by means of a bending cell made up of a pair of extensometric bridges 15 spaced along the wrench axis and connected in such a manner as to produce a signal differential between the innermost bridge and the outermost bridge and thus obtain a signal proportionate to the torque applied on the grip independent of its application point.

[0013] Thus pure torque measurement is possible by measuring bending far from the wrench rotation axis.

[0014] Advantageously the cell 14 bears at its external end the coupling seat of the interchangeable head and is rigidly fastened in a tubular bar 16 which joins with the body 11 to provide protection for the zone of the extensometers.

[0015] The body 11 contains a gyroscopic sensor 17 for measurement of the wrench rotation angle.

[0016] On the wrench body there is a panel 18 with a display 19 for information considered significant such as angle, torque, reaching of predetermined values, et cetera. A keyboard 20 permits setting wrench operation, inputting of parameters et cetera in combination with the information shown on the display. For example, in addition to showing numerical data the display can also show graphics in the various types of use and menus with icons to make use simple and intuitive by operators even not experts.

[0017] Advantageously there can also be provided LEDs 21 for visual signaling to the operator based on the result of a previously selected work method. For example lighting of a LED could warn of reaching a preset tightening value.

[0018] The wrench is equipped with power supply batteries which are advantageously contained in the grip 13 and can be recharged through an outlet 22 for connection to an external battery charger (not shown). The grip could have a fast closing plug for battery

change.

[0019] Another electrical outlet 23 permits exchange of data between the wrench and external computerized units (not shown) such as for example a personal computer.

[0020] FIG 2 shows a block diagram of the wrench. The gyroscopic sensor 17 is accomplished in the form of an optical gyroscope which was found advantageous due to the absence of moving parts, low power consumption, high precision and robustness. Advantageously the optical gyroscope is based on the known 'Segnac' effect.

[0021] The optical gyroscope comprises an optical fiber coil 24, a piezoelectric ceramic phase modulator 25, a coupler 26 which optically couples the ends of the optical fiber together to obtain a single fiber which traverses a polarizer 27 connected at its other end to another optical coupler 28 to which are connected a light source 29 and a photoelectric sensor 30.

[0022] Briefly, in accordance with known principles such as the 'Segnac' effect, light transmission time over a circular path in a rotating systems depends on the circulation direction. In the optical gyroscope the light produced by the source 29 is therefore divided in two beams which traverse the coil 24 in opposite directions. After passing through the coil the beams are recombined in the coupler 26 to generate an interference signal containing the so-called 'Segnac phase' information, i.e. the phase difference between the beams which is proportionate to the rotation speed of the ring 24. The interference signal is taken by the photoelectric sensor 30, amplified and processed by the conditioning block 31 which emits an electrical signal 32 proportionate to the rotation applied to the gyroscope.

[0023] The signal 32 is sent to a microprocessor circuit 33 which also receives the signal from the torque sensor 14. The circuit 33 processes the signal received and shows the result of the processing on the display 19 and if necessary sends it onto the connector 22. The circuit 33 also receives the command signals produced by the keyboard 20.

[0024] The microprocessor circuit 33 has a structure known in itself and therefore will not be further described nor shown.

[0025] During operation the circuit 33 samples the signal 32 at predetermined time intervals T. The value sampled represents the instantaneous wrench rotation velocity. If the value is zero the wrench has not moved since the last sampling. Otherwise the circuit calculates the integral of the velocity and adds it to the instantaneous velocity.

[0026] Multiplying the result by a constant K the angle traveled by the wrench is found. K is a function of sampling frequency, corresponding voltage-degrees per second of the signal 32, and corresponding tension-points of the analog to digital converter used in the acquisition.

[0027] It was discovered that extremely accurate measurements can be found with the gyroscope even at low rotation speeds.

[0028] Measurement drift values within the test duration range are extremely small and do not influence angle measurement precision.

[0029] The angle measurement process as described above is performed in parallel with the torque value acquisition performed by known methods. The circuit 33 employs the angle and torque values in a virtually known manner to supply desired functions and information.

[0030] Examples of typical wrench functions are the following.

a) Tightening with measurement of torque and angle while the circuit displays the torque and angle values on the display in real time and constantly updated.

b) Tightening to the elastic limit; from the torque/angle curve trend the microprocessor 33 determines when the straight line changes slope and the yield phase begins and signals to the operator, by lighting a LED for example, attainment of the elastic limit.

c) Checking bolts already tightened; measuring the torque to which a bolt was previously tightened can be done by measuring the torque necessary for imposing a further minimal rotation on the screw (first release torque). In this case, by setting a predetermined rotation angle above zero the wrench measures torque as soon as the angle sensor has measured the predetermined angle. Lighting of a LED can signal reaching this condition and hence the end of the test. As an alternative, retightening torque can be measured by moving the wrench to slightly loosen the bolt already tightened and then retightening the bolt. The circuit 33 memorizes the angle traveled during the loosening rotation and indicates return to the initial tightness by lighting a LED when the wrench has rotated back into the starting angular position. At the same time the tightening torque will be measured and displayed.

d) Tightness analysis. The wrench enables study of tightening characteristics by real time tracing on the wrench graphic display of an angle/torque curve representing the values detected during the test and which can be extended to breakage of a bolt.

[0031] Other functions can be provided for such as for example memorization of measured values, statistical processing thereof, et cetera.

[0032] It is now clear that the predetermined purposes have been achieved. The absence of mechanical connections to external references makes wrench use more practical, faster and flexible and at the same time avoids inaccuracy due to play in the connections. In addition there are no limitations during rotation of the wrench and a greater angular field is available with no

need of resuming the pull. With gyroscopic measurement there is optimal angle measurement precision even at low rotation speed, high measurement precision and repeatability even at constant speed and it is unnecessary for the operator to move the wrench at a specific velocity.

[0033] To this is added freedom to work in any position since the gyroscope supplies an absolute rotation measurement in any operational plane. In addition, use of the gyroscope together with use of extensometers which measure bending (instead of torsion on the wrench connection axis) permits providing interchangeable heads with ratchets, forks, polygonal, special et cetera without limit.

[0034] The use of an optical gyroscope eliminates the necessity of any moving part for angle measurement. In this manner there is also better strength and compactness of the wrench.

[0035] Naturally the above description of an embodiment applying the innovative principles of the present invention is given by way of non-limiting example of said principles within the scope of the exclusive right claimed here.

[0036] For example the wrench could be made with the electronic part separate and connected to the actual wrench through a cable for example to have a lighter wrench or to share a single electronic unit among several wrenches with different measurement capability.

Claims

1. Electronic torque wrench comprising a head for coupling with a member to be tightened, a first sensor for detecting the torque generated on the head upon moving the wrench, a second sensor for detecting angular rotation of the head and means of calculation to find from the sensor measurement information considered significant characterized in that the angular rotation sensor comprises a gyroscopic sensor.

2. Wrench in accordance with claim 1 characterized in that the gyroscopic sensor is an optical fiber gyroscope.

3. Wrench in accordance with claim 2 characterized in that the optical fiber gyroscope is a 'Segnac' effect gyroscope.

4. Wrench in accordance with claim 1 characterized in that the gyroscope is arranged in a wrench body part far from the head.

5. Wrench in accordance with claim 1 characterized in that the coupling head is changeable by means of a bayonet joint.

6. Wrench in accordance with claim 1 characterized in that the first sensor is located along the connection wrench axis between the head and a handling grip.

7. Wrench in accordance with claim 1 characterized in that the torque measurement sensor uses extensometers for measurement of the bending of one part of the wrench.

8. Wrench in accordance with claim 7 characterized in that the extensometers are two complete bridges spaced apart along the wrench axis to supply a measurement differential between the innermost bridge and the outermost bridge and thus obtain a signal proportionate to the torque applied on the grip which is independent from its point of application.

9. Wrench in accordance with claim 1 characterized in that it comprises a panel having an information, data and graphics viewing display and an input keyboard.

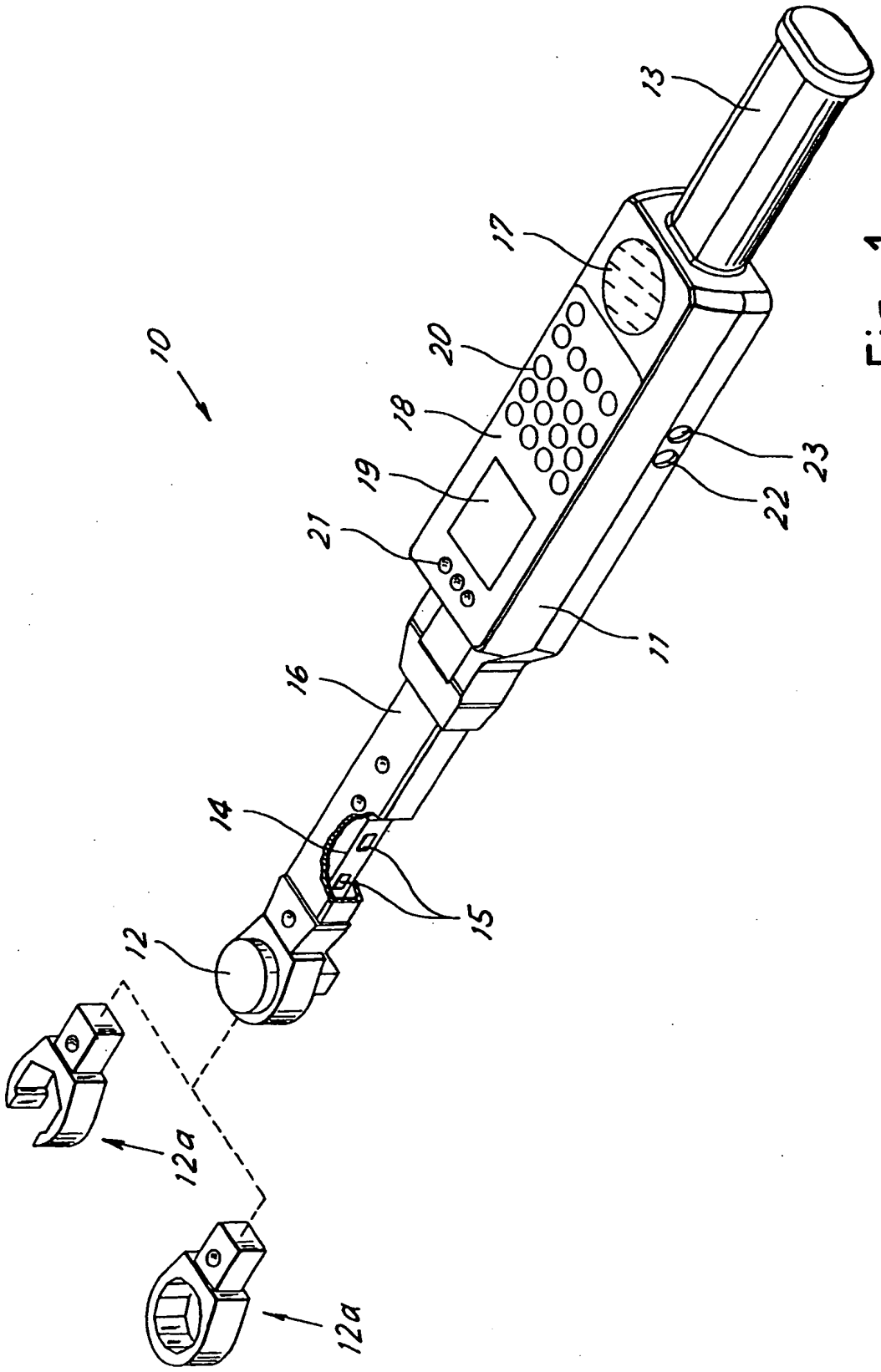

Fig. 1

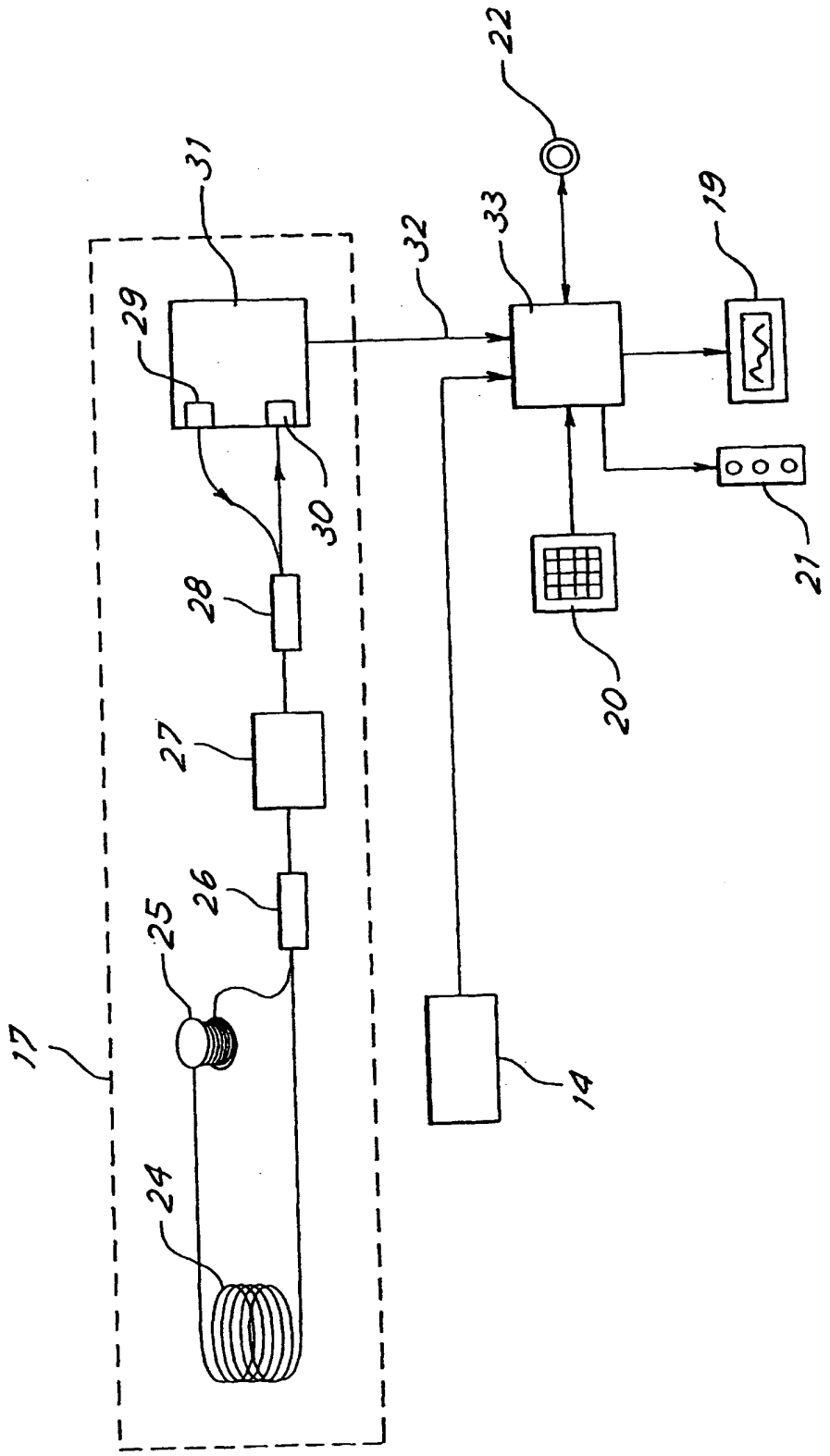

Fig. 2

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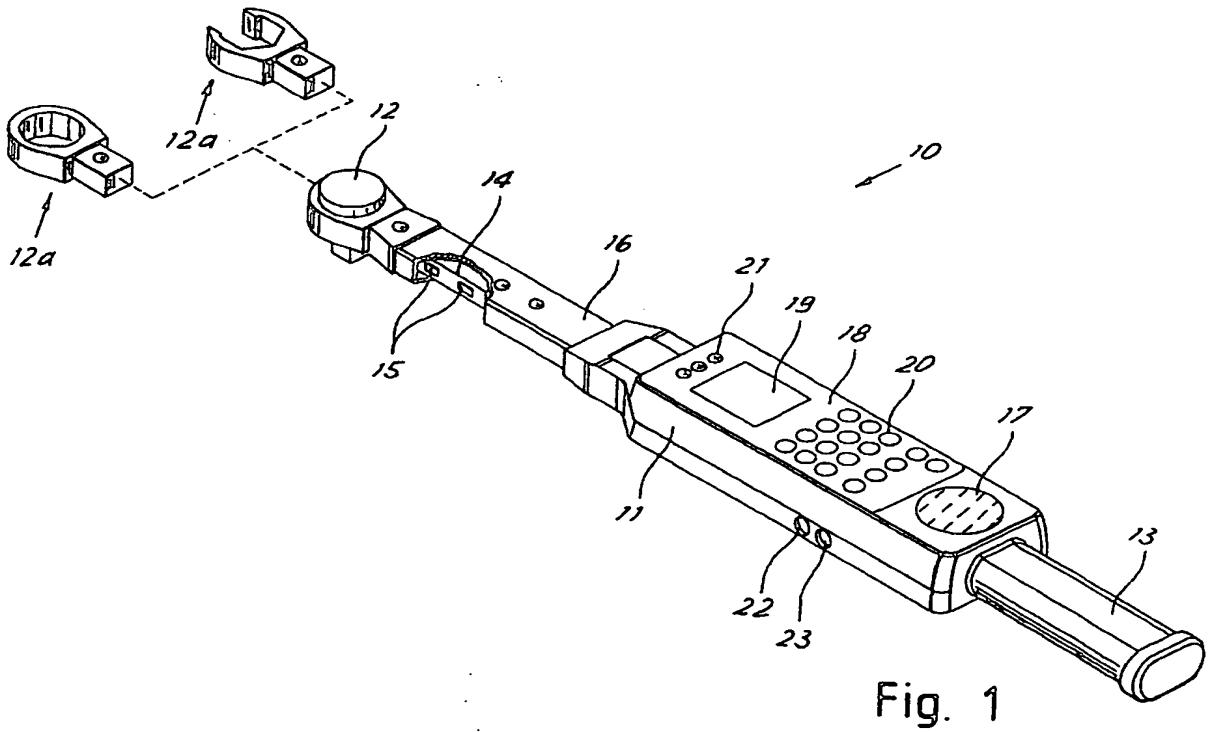

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 00 20 0210

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	US 5 476 014 A (LAMPE MARKUS ET AL) 19 December 1995 (1995-12-19) * column 3, line 27 - column 3, line 40 * * column 4, line 9 - column 4, line 22 * * column 4, line 50 - column 5, line 15 * * column 5, line 40 - column 5, line 52 * * column 6, line 13 - column 6, line 24 * * column 6, line 59 - column 7, line 35 * * column 7, line 64 - column 8, line 10 * * column 8, line 25 - column 8, line 34 * * figures * ---	1-4,6 5,7-9	B25B23/142
Y A	FR 2 538 741 A (FACOM) 6 July 1984 (1984-07-06) * figures * ---	5 1,6,7	
Y A	US 4 976 133 A (POHL PETER) 11 December 1990 (1990-12-11) * column 5, line 42 - column 7, line 24; figures 1-3 * ---	7-9 1,6	
X A	US 5 589 644 A (BECKER THOMAS P ET AL) 31 December 1996 (1996-12-31) * column 3, line 26 - column 3, line 65; figure 1 * * column 5, line 55 - column 5, line 63 * ---	1,4 2,3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B25B
A	DE 42 43 317 A (HINÜBER EDGAR) 9 June 1993 (1993-06-09) * column 1, line 37 - column 2, line 28; claim 3; figure 2 * ---	1-4	
A	DE 296 15 123 U (WILLE GMBH & CO) 8 January 1998 (1998-01-08) * page 9, line 20 - page 15, line 2; claims 1,7,8,12,16; figures 1-3 * -----	1,7,9	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	2 December 2002	Kühn, T

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02-12-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5476014 A	19-12-1995	DE 4243317 A1	09-06-1993
		DE 9311013 U1	02-09-1993
		DE 4343110 A1	23-06-1994
		ES 2092951 A2	01-12-1996
		FR 2699446 A1	24-06-1994
		GB 2273574 A ,B	22-06-1994
		JP 3131891 B2	05-02-2001
		JP 6210574 A	02-08-1994
FR 2538741 A	06-07-1984	FR 2538741 A1	06-07-1984
US 4976133 A	11-12-1990	DE 3840684 A1	07-06-1990
		DE 58906167 D1	16-12-1993
		EP 0372247 A2	13-06-1990
		JP 2262968 A	25-10-1990
US 5589644 A	31-12-1996	CA 2182515 A1	06-06-1996
		DE 19581468 T0	02-01-1997
		GB 2301054 A ,B	27-11-1996
		JP 10501186 T	03-02-1998
		WO 9616761 A1	06-06-1996
DE 4243317 A	09-06-1993	DE 4243317 A1	09-06-1993
		DE 4343110 A1	23-06-1994
		ES 2092951 A2	01-12-1996
		FR 2699446 A1	24-06-1994
		GB 2273574 A ,B	22-06-1994
		JP 3131891 B2	05-02-2001
		JP 6210574 A	02-08-1994
		US 5476014 A	19-12-1995
DE 29615123 U	08-01-1998	DE 29615123 U1	08-01-1998
		FR 2752765 A3	06-03-1998
		IT 1294353 B1	24-03-1999

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82